Geosil – ready to use alkali silicates for Geopolymers

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<th>Title</th>
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<td>Brief introduction Woellner Group</td>
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<td>Production route, properties and basics of water glass</td>
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<td>Geosil &amp; Betol products</td>
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Introduction

- Owned by Dr. Eduard Wöllner family foundation
- 120 years of experience (founded in 1896)
- Head Office in Ludwigshafen / Germany
- Main product groups:
  - industrial silicates
  - raw materials and additives for paints, plasters and construction materials
  - process chemicals for industrial water circuits
- Approx. 140 employees
- Annual turnover approx. 50 million Euros
Production Sites

Ludwigshafen: headquarter and production site

Bad Köstritz: production site

Gratwein-Straßengel: sales department and production site
Waterglass

- not distinct stoichiometric chemical substances
- no specific chemical formula
- glasses or aqueous solutions of glasses
Melting/Solving Process

- Quartz
- Alkali Carbonate

Glass kiln

- Autoclave
- Storage tank

Filter

storage

fine tuning

glass lumps

water
Hydrothermal process

\[ 2 \text{MOH} + x \text{SiO}_2 \rightarrow \text{M}_2\text{O} \cdot x \text{SiO}_2 + \text{H}_2\text{O} \]

M = Na, K, Li

Diagram:
- Silica source
- Hydroxide
- Autoclave
- Storage tank
- Filter
- Fine tuning
- Storage

Water
Definition molar ratio

**Weight ratio:**
\[ WR = \frac{\text{wt.\% SiO}_2}{\text{wt.\% M}_2\text{O}} \]

**Molar ratio:**
\[ MR = \frac{\text{mol SiO}_2}{\text{mol M}_2\text{O}} \]

* Molar Ratio \(\Leftrightarrow\) Weight Ratio

- Sodium silicate: Molar Ratio = 1,032 \(\cdot\) Weight Ratio
- Potassium silicate: Molar Ratio = 1,566 \(\cdot\) Weight Ratio
Properties according molar ratio

<table>
<thead>
<tr>
<th>Molar Ratio</th>
<th>Alkalinity</th>
<th>Buffering</th>
<th>Solubility</th>
<th>Bound Moisture</th>
<th>Drying time</th>
<th>Reactivity</th>
<th>Dried Strength</th>
<th>Viscosity</th>
<th>Sensitivity to Cold</th>
<th>Chemical Resistance</th>
<th>Bonding Force</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.6</td>
<td>↑</td>
<td></td>
<td>↓</td>
<td>↑</td>
<td>↑</td>
<td>↓</td>
<td>↓</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
</tr>
<tr>
<td>2.0</td>
<td>↑</td>
<td></td>
<td>↓</td>
<td>↑</td>
<td>↑</td>
<td>↓</td>
<td>↓</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
</tr>
<tr>
<td>2.4</td>
<td>↑</td>
<td></td>
<td>↓</td>
<td>↑</td>
<td>↑</td>
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<td>↓</td>
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</tr>
<tr>
<td>2.8</td>
<td>↑</td>
<td></td>
<td>↓</td>
<td>↑</td>
<td>↑</td>
<td>↓</td>
<td>↓</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
</tr>
<tr>
<td>3.2</td>
<td>↑</td>
<td></td>
<td>↓</td>
<td>↑</td>
<td>↑</td>
<td>↓</td>
<td>↓</td>
<td>↑</td>
<td>↑</td>
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</tr>
</tbody>
</table>

molar ratio
technical significant liquid silicates:

Sodium silicate: molar ratio 1,7 – 4
Potassium silicate: molar ratio 0,5 – 4
Lithium silicate: molar ratio 2,5 – 5,0

Suitable silicates for Geopolymer:

Sodium silicate: molar ratio 1,7 – 2,0
Potassium silicate: molar ratio 1,5 – 2,3
## Classification (soluble silicate solutions)

<table>
<thead>
<tr>
<th>Molar ratio SiO₂ : M₂O</th>
<th>„Old“ Classification (Handling)</th>
<th>Dangerous Goods Classification (Transport)</th>
<th>CLP-Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt; 3,2 (conc. &lt; 40 %)</td>
<td>none</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>&gt; 3,2 (conc. &gt; 40 %)</td>
<td>Xi irritant R 36/38</td>
<td>none</td>
<td>Warning</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Skin Irrit. 2 H315</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Eye Irrit. 2 H319</td>
</tr>
<tr>
<td>&gt; 2,6 ≤ 3,2</td>
<td>Xi irritant R36/38</td>
<td>none</td>
<td>Warning</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Skin Irrit. 2 H315</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Eye Irrit. 2 H319</td>
</tr>
<tr>
<td>&gt; 1,6 ≤ 2,6</td>
<td>Xi irritant R38, 41</td>
<td>none</td>
<td>Danger</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Skin Irrit. 2 H315</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Eye Dam. 1 H318</td>
</tr>
<tr>
<td>≤ 1,6</td>
<td>C corrosive R34</td>
<td>Cl. 8 / VGr. II</td>
<td>Danger</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Skin corr. 1B</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Eye Dam. 1 H314</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Met. corr. 1 H290</td>
</tr>
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## GEOSIL® Products

<table>
<thead>
<tr>
<th>Name</th>
<th>Type</th>
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<tbody>
<tr>
<td>Geosil 34417</td>
<td>Sodium silicate</td>
</tr>
<tr>
<td>Geosil 54217</td>
<td>Sodium / potassium mixed silicate</td>
</tr>
<tr>
<td>Geosil 14515</td>
<td>Potassium silicate</td>
</tr>
<tr>
<td>Geosil 15517</td>
<td>Potassium silicate</td>
</tr>
<tr>
<td>Betol VP6079</td>
<td>Alumosilicate based hardener</td>
</tr>
<tr>
<td>Betol H31</td>
<td>Alumosilicate based hardener</td>
</tr>
<tr>
<td>Geosil 14423</td>
<td>Potassium silicate</td>
</tr>
</tbody>
</table>
Why Geosil?

- ready formulated mixtures
- quality controlled process
- userfriendly - no hydroxide handling
- high purity of raw materials
- reproduceable & controlled production process
- stable solution
- worldwide shipping possible
- guarantee of chemical composition
- long shelf life
Binder dominant

- Aluminium silicate
- Geosil® / H₂O

filler dominant

- Betol H31
- Geosil® 14423

mix

filler

cast

hardening ambient temp.

mix

filler

compact

hardening with temperature
## Application with Geosil® Binder

<table>
<thead>
<tr>
<th>Binder dominant</th>
<th>Filler dominant</th>
</tr>
</thead>
<tbody>
<tr>
<td>- geopolymer concrete</td>
<td>- acoustic boards</td>
</tr>
<tr>
<td>- geopolymer adhesive</td>
<td>- thermal insulation boards</td>
</tr>
<tr>
<td>- geopolymer mortar</td>
<td>- fire protection boards</td>
</tr>
<tr>
<td>- Inorganic foam</td>
<td>- refractory bricks</td>
</tr>
<tr>
<td>- toxic waste immobilisation</td>
<td>- pavement stone</td>
</tr>
<tr>
<td>- composites</td>
<td>- facade elements</td>
</tr>
<tr>
<td>- steel coating</td>
<td>- core binder foundry</td>
</tr>
<tr>
<td></td>
<td>- Arts &amp; decoration</td>
</tr>
</tbody>
</table>
Binder dominant

cast fly ash based Geopolymer

cast Geopolymer wash bowl

50Mpa compressive strength (28d)

cast Geopolymer brick
Filler dominant

desert sand geopolymer bonded

Geopolymer bonded MgO

GP lightweight epoxy composite

lightweight insulation of clay bricks
Summary: customer questions

- Which raw material to choose?
- Which alkali silicate to choose?
- Which aluminium silicate to choose?
- Which filler/other raw materials to choose?
- How to avoid crack formation?
- How to avoid shrinkage?
- How to control cure process?
- How to find the right mixture?
- How to develop 1K System?
- Which standard to use?
- How to understand chemical reactions?
Summary: how Wöllner can support you

- „Geosil“ Binder - ready to use activator solution
- Hardener for Geosil Binder
- customized products (blends, modified products)
- Additives stable at high pH-values (thickener, dispersing-agent, hydrophobic agent)
- Worldwide logistic for all products
- Individual technical support for customers
- Worldwide network with international partners
The partner by your side